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Factors Affecting the Marketing of Onions by Smallholder Producers in Gololcha District, Arsi Zone, Oromia National Regional State, Ethiopia

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Abstract The study utilized descriptive statistics and econometric models to analyze the socio-economic characteristics of sampled producers in the Gololcha Arsi Zone, Oromia Regional State. The research was carried out in Gololcha Woreda, Arsi Zone, using random and purposive sampling methods. A total of 114 respondent households, predominantly male-headed, participated in the study. Smallholder farmers dedicated an average of 0.27 hectares of land to onion production, with an average yield of 19.69 quintals per household. The mean income from onion bulb sales in the 2022 production year was 332,824.60 Birr. Multiple linear regression models were employed to investigate the marketing supply of smallholder onion producers, revealing that eight explanatory variables were significantly associated with onion sales volume in the market at a 0.5 level of significance. Factors such as onion production quantities, farmers' experience, insecticide usage, and total income were positively correlated with onion supply, while farm size, fungicide usage, oxen utilization, and average onion price were negatively correlated. Formal institutions were the main sources of onion seeds in the study area, offering improved varieties like Bombay Red, Adama Red, and Nafis. Challenges in the area included production and marketing issues, informal seed sources, diseases, insects, poor production practices, and lack of market information. Despite these challenges, producer farmers in the study area had access to opportunities such as improved onion varieties, connections with agriculture offices and research centers, irrigation water resources, training facilities, local traders and wholesalers, infrastructure development, labor availability, and experienced onion producers.

Keywords Descriptive statistics, onion production, access to institutions, technologies, market supply, econometric model, opportunity and challenges

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1. Introduction

Ethiopia is known as one of the most underdeveloped and impoverished countries in the world. The agricultural sector in Ethiopia is predominantly composed of small-scale rain-fed farming, which makes up about 94% of agricultural GDP and 90% of agricultural production. The remaining percentage comes from a small number of state-owned or private commercial farms (Louhichi, K. et al., 2019; National Planning Commission (NPC), 2016). Despite having a long history in the country's economy, the agriculture sector's development has been impeded by various constraints such as soil erosion, a shortage of agricultural inputs, a weak organizational structure, and a lack of efficient agricultural policies and strategies (Alemayehu Hailu, 2016).

Horticultural crops, particularly vegetable production and marketing, play a vital role in countries like Ethiopia by increasing farmers' income and improving nutrition. Vegetable production is labor-intensive and provides employment opportunities. Vegetables are a key source of vitamins and minerals for a balanced diet. Diversifying and improving vegetable production can help reduce malnutrition and poverty, increase home consumption, and create new market opportunities for farmers. Additionally, vegetable marketing creates new income and job opportunities in trading and processing sectors Aklilu Amsalu, (2015) and Alemnewu Abay, (2010).

Vegetable crops like onion, tomato, potato, beetroot, carrot, cabbage, sweet potato, and pepper are extensively grown in Ethiopia. Among these, onion is the most important vegetable cultivated on a large scale in the country. The cultivation of onions is increasing due to its profitability per unit area, ease of production, and the expansion of small-scale irrigation areas in Ethiopia (Weldemariam, S. et al., 2015).

During the 2022/23 production period in Ethiopia, the total estimated yield was 268,737.43 tons, cultivated over an area of 31,579 hectares; with an average yield of 85.10 qt/ha (FAO, 2023). Onions are a vital cash crop in Ethiopian agriculture, grown in various regions for both local consumption and export (Adugna, 2021). Onion production and marketing play a crucial role in poverty reduction by creating employment opportunities for smallholders (Agidew Abebe, 2018). The demand for onion products is increasing, while supply is struggling to keep up. Market inefficiencies and lack of balanced market information are obstacles to maximizing profits that could be achieved with complete data (Nakasone, E., 2014). Gololcha district in Arsi Zone is a significant vegetable producer, particularly renowned for its onion cultivation, benefiting from abundant resources and favorable agro-ecology for onion production. Despite these advantages, there is a lack of comprehensive research on the factors influencing onion marketing in Gololcha District. This knowledge gap could potentially hinder onion productivity and food security in the region. Therefore, this study aims to uncover the key determinants of onion marketing in the district.

Onion (Allium cepa L.) production status in Ethiopia

Onions or shallots are cultivated in various tropical countries in Africa, including Ethiopia (Grubben and Denton 2004). This has led to an increase in onion production in different agro-ecologies and small-scale farming systems, benefiting both rural and urban communities. However, the industry faces challenges such as a lack of improved cultivars, diseases, and insect pests, as well as limited attention to production and disorganized marketing systems, hindering progress. According to data from CSA (2020/21), the onion cultivation area during the rainy season in Ethiopia is 38,952.58 ha, with an annual harvest of 34,604.81 tons and an average yield of 89.71 qt/ha, which is lower than other onion-producing countries. The lower productivity in Ethiopia is attributed to factors such as diseases, pests, limited use of improved varieties, and suboptimal agricultural practices by farmers. Implementing proper agronomic practices can enhance crop production and productivity. Recent efforts by the government to promote best practices, increase irrigation infrastructure, and support smallholder farmers in producing high-value crops like onions have shown some progress in onion production. The production trends show fluctuations, with the highest annual growth rate (38.51%) recorded after 2022 compared to the previous six years (CSA 2017-2022).

Table 1: Onion production trends in Ethiopia, 2017-2022

Crop	Year	Area (ha)	Production in Qt	Yield in qt	Annual production change/ Growth
Onion	2016/17	33,603.39	3,274,752.45	97.45	-
	2017/18	31,673.21	2,938,875.85	92.79	-10.26%
	2018/19	28,185.11	2,624,782.85	93.13	-10.69%

	2019/20	36,276.17	2,576,661.90	75.29	4.34%
	2020/21	38,952.58	3,460,480.88	89.71	34.30%
	2021/22	25,237.55	2,076,626.76	82.28	-38.51%
		32,321.34	2,825,363.45	88.44	-3.47

Central Statistical Agency's Agricultural Sample Survey Data, (CSA, 2017-2022)

Marketing of onion

Marketing of vegetables requires more attention compared to food grains due to their perishable nature. Among vegetables, onions have the advantage of being less perishable and are able to enter interstate and foreign trade channels to a significant extent. This is because they can withstand rough handling and long-distance shipment. Onions can be stored after harvest for a considerable period using ordinary methods, even under unfavorable weather conditions. They can be sold at a later date when market prices are favorable to producers. Onions have a longer shelf life in the market compared to other vegetables, providing ample opportunities to increase their cultivation by improving marketing facilities, introducing high-yielding varieties, and implementing modern agricultural practices for onion growers (Kumar et al. 2016). In the study area, onion marketing emerged as a major issue involving various stakeholders.

Access to marketing information was identified through a semi-structured questionnaire and focus group discussions. Marketing linkages and participation were assessed in terms of percentage share and ranking.

Major Opportunities and challenges of onion production and marketing

Opportunities

The potential for groundwater development for second-cycle irrigation, the presence of Farmer Training Centers, ongoing infrastructure projects, rural electrification, improved rural roads, organized farmer cooperatives for irrigation water use, wholesale trade availability, extension services connecting farmers to agricultural offices, and research facilities are key opportunities for enhancing onion variety production in Ethiopia (Kassa and Ahmed, 2018; Abebe, 2018). These opportunities were identified as significant factors in the study of Gololcha Woreda through focus group discussions in three kebeles known for onion bulb production.

Major challenges of onion production and marketing

Based on recent evidence, challenges such as poor cultivar quality, disease and pests, inadequate extension systems, climatic variability, and subpar agronomic practices are hindering the production of improved onion varieties in Ethiopia. These constraints have been identified by various studies (Misgana and Awoke, 2018; Muluneh et al., 2019; Agidew, 2018; Taye et al., 2018; Addisu et al., 2017; Habtamu, 2017; Kassa and Ahmed, 2018). Despite the importance of onion production as a source of income in Ethiopia, there are obstacles in the marketing process, including issues with product handling, price information accuracy, lack of coordination among producers, weak market linkages, and absence of quality standards and grades (Samuel, 2003; Abebe, 2018). These challenges were identified through surveys and discussions in the study area involving three villages and three groups of onion producers and marketers.

2. Materials and Methods

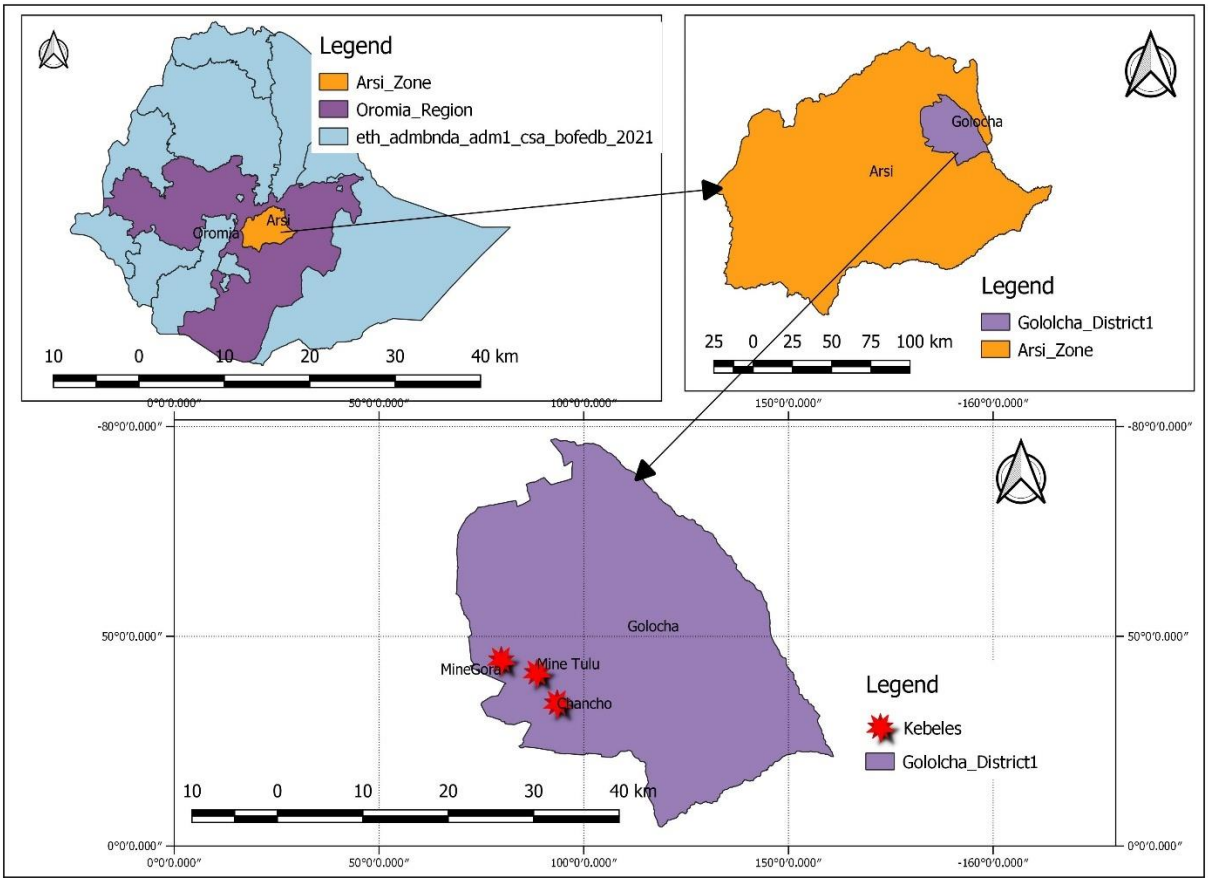
To analyze the gathered data and meet the goals of the study, descriptive and econometric techniques were applied. Among the econometric models, a multiple linear regression model with a constant term was used. Both quantitative and qualitative data collected was analyzed using Stata-17 version.

2.1. Description of the Study Area

The study area Gololcha Woreda is situated in the Arsi Zone of the Oromia regional state in Ethiopia. The zone is centrally located within the Oromia National Regional State, with coordinates ranging from 60 45' N to 58'N and 38 32 E to 40 50' E. It shares borders with the Southern Nations, Nationalities, and Peoples' Region, as well as with the East Shewa, Bale, and West Hararghe Zones. The East Shewa Zone accounts for approximately 43 percent of the Arsi Zone's total boundary length, making it the longest border at 450km. The second longest border (350km) is shared with the Bale Zone. The shortest border (43km) is with the Southern Nations, Nationalities, and Peoples' Region. The

capital town of the zone is Asella, located 175 km from Finfinne on the Finfinne-Adama-Bale Robe main road. Asella is also situated 75 km south of Adama town (Abdi, 2017).

The study area in Gololcha district is bordered by Aseko district to the north, Amegna district to the south, Shanan Kolu district to the east, and Chole district to the west. The altitude of the district ranges from 1400 to 2500 meters above sea level. The district covers a total area of 178,102 hectares and is divided into two agro-ecologies: midland (25%) and lowland (75%). Gololcha district has an average temperature of 35˚C and receives an average annual rainfall of 900 mm. The main rainy season in the district occurs from April to September. The soil type in the district is silt and sandy soil. Major crops grown in the area include Coffee, Maize, Sorghum, Teff, and Groundnut (GWoA, 2022). The district consists of 23 rural kebeles, with 15 of them being onion producers. Among these, eight kebeles produce onion bulbs, while seven kebeles produce onion seeds as income-generating activities (unpublished GDOoANR, annual report, 2023). A map of the study area is shown in Figure 2 below.



Source: Own sketch From Ethiopia-GIS, (2024).

Figure 1: Map of the Study Area

2.2. Method of data collection

The data was collected from primary and secondary sources. Primary data was obtained from sample respondents through semi-structured questionnaires, focus group discussions, and key informant interviews. According to Douglas, M. (2015), primary data is original and unique data collected directly by the researcher from study areas such as observations, surveys, questionnaires, case studies, and interviews related to the study topic or objectives. Secondary data sources consist of published and unpublished documents, government publications, websites, books, journal articles, and internal records, as stated by Mesly (2015).

Semi-structured Questionnaires: Research assistants carried out data collection by translating a semi-structured questionnaire into the local language. The questionnaire underwent pre-testing to ensure clarity, validity, and proper sequence, and was refined based on feedback. Both qualitative and quantitative data were collected using the questionnaire to investigate informal onion seed marketing systems in line with the study objectives. The data

collected included a mix of quantitative and qualitative information gathered through semi-structured questionnaires. The qualitative data aimed to complement the quantitative results.

Focus Group Discussion (FGD): Focus group discussions were carried out in three kebeles (Chancho, Mine Tulu, and Mine Gora) to collect qualitative data on production and marketing constraints, technology access, challenges, and opportunities in households involved in onion bulbs production and marketing.

Key Informant Interview: A key informant interview was carried out to collect qualitative data on onion seed varieties, production, and productivity, inputs, pricing, and marketing challenges. The interview involved wholesalers, retailers, local traders, brokers, and cooperatives. The data was analyzed to assess institutional linkages and market participation, understand onion seed production and distribution, and determine their importance in the study area.

2.3. Data type and Sources

Both primary and secondary data were utilized as sources of information. Primary data was gathered through in-person interviews using a semi-structured questionnaire.

2.4. Sampling techniques and sample size determination

The research was conducted in Gololcha Woreda, Arsi Zone, utilizing random and purposive sampling techniques. Respondents were selected randomly, and three out of seven possible kebeles were chosen purposively, namely Mine Tulu, Mine Gora, and Chancho. The sample size was calculated following the formulas outlined by Cochran (1963) and Marshall et al. (2013) at a significance level of 5%.

$$n = \frac{Z^2 p q}{e^2}$$

The formula for determining the confidence level (95%), precision (e), and estimated proportion of an attribute in the population (p) is q = 1-p. Assuming a large population with unknown variability in practice adoption, p= 0.5, a 95% confidence level, and ±5% precision is used to minimize costs. The sample size (n) is calculated using the Cochran formula:

n = (Z2 * p * (1 - p) / e2) / (1 + (Z2 * p * (1 - p) / (e2 * N))

Here, Z = 1.96 for a 95% confidence level, p = 0.5, N = 160, and e = 0.05.

Substituting these values:

n = (1.962 * 0.5 * (1 - 0.5) / 0.052) / (1 + (1.962 * 0.5 * (1 - 0.5) / (0.052 * 160))

n = 384.16 / 3.369 = 114

Based on the Cochran formula calculated above a total of 114 of sample households were considered from 160 target population during the interview schedule in the three kebeles of the one Woreda.

Table 2: Households sample design

District	Sample kebeles	Total number of HHs			Sample HHs		
		Male	Female	Total	Male	Female	Total
Gololcha	Chancho	95	20	115	17	0	17
	Mine Gora	782	140	922	46	3	49
	Mine Tulu	704	120	824	48	0	48
Total		1581	280	1861	111	3	114

Source: Computed from Primary survey data and annual report of GWOANR Office, (2023).

2.5. Method of data analysis

The data collected were analyzed using descriptive statistics and econometric models, including percentages, frequencies, mean, standard deviation, and graphical representation of the socio-economic characteristics of the sampled producers.

The study utilized a multiple linear regression model to assess the factors influencing the quantity of onions supplied to the market. These factors encompassed the age of the household head, family size, experience in onion bulb production, educational levels, distance to the main market, land allocated for onion cultivation, application of NPS & URA, use of fungicides and insecticides, production quantity, market supply, labor availability, oxen utilization, off/non-farm income, and average selling price of onions. The multiple linear regression model, as discussed by Lyman and Michael (2010), Quick (2013), and Dattalo (2013), examines the linear relationships between dependent and independent variables in multiple sets, assuming a normal distribution of the dependent variables for multivariate multiple linear regression.

The study examined the connection between these variables and the production and supply of onions in the market. Multivariate multiple linear regression models were used to assess the factors influencing the amount of onions produced and supplied to the market. As per Lyman and Michael (2010), Quick (2013), and Dattalo (2013), the multiple linear regression equation is represented as: $Y = \beta 0 + \beta i\, Xi + Ui$.

$Yi = \beta 0 + \beta 1\, X1 + \beta 2\, X2 + \beta 3\, X3 + \beta 4\, X4 + \beta 5\, X5 + \beta 6\, X6 + \beta 7\, X7 + \beta 8\, X8 + \beta 9\, X9 + \beta 10\, X10 + \beta 11\, X1\, \beta 12\, X12 + \beta 13\, X13 + \beta 14\, X14 + \beta 15 X15 + Ui$

Where:

Yi= Mrktspply = Represents quantity supplied to the market in qt,

β0 = Constant or variables coefficients (slopes)

βi = Estimated coefficients of the explanatory variables

Xi = Explanatory variables, and

Ui = Disturbance term/ error terms

BXi= Coefficients of Independent Variables, these variables include:

Age = Farmers age

Fsize = Family size

Edu = Educational Levels

Exp = Farmers experiences in onion production

Dstmarkt = Time taken to the main market

Frmsize = Land allocated to produce onion in ha

NPS = Amount of NPS applied to produce onion in qt

URA = Amount of UREA applied to produce onion in qt

Fngcdamnt = Amount of fungicide applied to produce onion in mg or liters

Insctcdamnt = Amount of insecticide applied to produce onion in liters

Avrgprcekg = Average price of onion in one kg

Saleofonion = Total income from the sale of onion in Birr

Oxen= Numbers of oxen used for plowing onion farm

Labor = Numbers of labor availability to produce onion

e = error term (variance)

2.5.1. Diagnoses test

Prior to fitting the model to the data, the presence of significant multicollinearity among the explanatory variables was assessed using the Variance Inflation Factor (VIF). According to Gujarati (2004), a VIF greater than 10 indicates high collinearity. In this study, VIF was calculated before incorporating key variables into the regression models to examine the extent of multicollinearity. Since all VIF values were below 10, there was no significant issue of multicollinearity among the independent variables. As per the guideline by Gujarati and Porter (2003), a VIF exceeding 10 suggests high collinearity among explanatory variables. However, the VIF values of the variables included in the model were all below 10, indicating the absence of a serious multicollinearity problem.

Table 3: Multicollinearity test result

Variable	VIF	1/VIF
Saleofonion	21.48	0.046546
Qtprd	16.26	0.061509
Age	3.34	0.299636
Fsize	3.3	0.303361
Frmsize	2.75	0.364037
Avrgprcekg	2.67	0.374192
Fngcdamnt	2.21	0.452955
Insctcdamnt	2.03	0.493112
NPS	1.45	0.68927
Exp	1.44	0.692533
UREA	1.26	0.79092
Oxen	1.18	0.847863
Dstmarkt	1.16	0.865372
Labor	1.15	0.867649
Edu	1.14	0.879691
Mean VIF	4.19	

Survey data model output result, (2015).

Heteroscedasticity

The coefficient of determination (R2) is a measure used to evaluate the overall goodness of fit of a model by determining how much of the variation in the dependent variable can be explained by the variation in the explanatory variables. A higher R2 value indicates a better fit, with values closer to 1 indicating a stronger fit. In this instance, the econometric model analysis resulted in an R2 value of 0.985, indicating that the model was well-specified and did not exhibit heteroscedasticity.

A correlation matrix shows the correlation coefficients between variables, ranging from -1 to +1. A coefficient of -1 indicates a perfect negative correlation, +1 indicates a perfect positive correlation, and 0 indicates no linear correlation (Field, 2013). There is a strong positive correlation between market supply (Mrktspply) and quantity produced (Qtprd) (r = 0.9710), indicating that as onion production increases, market supply also increases significantly. This aligns with market principles (Mankiw, 2014) and underscores the importance of production volume for onion marketing in Gololcha. The correlation between farmer's education (Edu) and farm size (Frmsize) is weak and negative (r = -0.0507), suggesting little to no linear relationship between education level and farm size in this region. This discrepancy may be influenced by factors like land inheritance or alternative livelihood strategies (Doss, 2006), warranting further investigation in the Ethiopian agricultural context.

Table 4: VIF of the model test

	Age	Fsize	Edu	Exp	Dstmerk	Frmsize	NPS	UREA	Fngcda~t	Insctc~t	Qtprd	Mrktsp~y	AvrgP
Age	1.0000												
Fsize	0.8122	1.0000											
Edu	-0.0471	-0.1004	1.0000										
Exp	-0.0344	-0.0197	0.0868	1.0000									
Dstmerk	-0.1155	-0.1971	-0.1174	-0.0082	1.0000								
Frmsize	-0.0399	-0.0406	-0.0507	0.3229	-0.0228	1.0000							
NPS	-0.0651	-0.0385	-0.0271	0.0244	-0.0663	0.2664	1.0000						
UREA	-0.0878	-0.0273	0.0719	0.0070	0.0424	0.0618	0.3398	1.0000					
Fngcdamnt	0.0136	-0.0337	-0.0406	-0.0843	-0.1697	0.3161	0.1172	0.0930	1.0000				
Insctcdamnt	-0.1026	-0.1287	0.1119	-0.0964	-0.1523	0.1084	-0.0503	-0.0498	0.6445	1.0000			
Qtprd	0.0680	0.1159	-0.0959	0.3940	-0.0798	0.7141	0.4005	0.1207	0.1661	-0.0379	1.0000		
Mrktspply	0.0469	0.1134	-0.1201	0.3794	-0.0575	0.6902	0.4073	0.1091	0.1302	-0.0619	0.9710	1.0000	
AvrgPrcekg	0.0318	0.0744	-0.1126	-0.0081	-0.0649	0.1796	0.2611	0.0205	0.1596	-0.0634	0.3310	0.4002	1.0
Saleofonion	0.0509	0.1024	-0.1140	0.2793	-0.0721	0.7125	0.4296	0.0776	0.1858	-0.0626	0.9386	0.9666	0.5
Oxen	0.0882	0.0337	0.1198	0.0589	-0.1128	0.0080	-0.1522	-0.1343	0.0242	0.1346	0.0206	-0.0419	-0.2
Labor	0.2770	0.1651	0.1146	-0.0709	-0.1030	-0.0590	-0.0224	0.0322	0.0606	0.0495	-0.0057	-0.0156	0.0

	Saleof~n	Oxen	Labor
Saleofonion	1.0000		
Oxen	-0.0505	1.0000	
Labor	-0.0085	0.0560	1.0000

Source: Survey data VIF test result, (2015).

2.5.2. Operationalization of Variables

The study examines the factors that impact onion market supply by producers, specifically looking at how these factors may affect and relate to dependent variables. A total of fifteen explanatory variables were chosen for the model estimation, based on a review of existing literature and available data sets. The meanings of these fifteen explanatory variables are detailed below:

2.5.2.1. Dependent Variable

2.5.2.1.1. Market supply of onions seed (Mrktspply):

The quantity of onion supplied to the market is a continuous variable and acts as the dependent variable. It represents the amount of onion that households bring to the market and is measured in quintals, where one quintal is equivalent to 100 kilograms. This continuous variable is shown as such in the research conducted by Haji & Alemu (2012) and Tola & Ketema (2014).

2.5.2.2. Independent variables

2.5.2.2.1. Quantity of onion produced (Qtprd):

The amount of onion produced is a continuous variable measured in quintals, and a higher yield increases the likelihood of the household selling to the market. Therefore, in this study, the total onion production by the farm household is expected to have a positive impact on market supply. The quantity of onion produced is an economic factor and a continuous variable that can affect the volume of sales at the household level, measured in quintals. When the quantity of onion produced is increased through improved onion and fertilizer, it is expected to have a positive effect on market supply, as farmers with higher yields can supply more to the market than those with lower yields. Abraham Tegegn (2013) found that an increase in vegetable production by farming households significantly increases the marketed output of the commodities. According to Addisu et al. (2017), the quantity of vegetables produced has a positive and significant influence on the quantity of vegetables supplied to the market.

Hence, it is theorized that the amount of onion produced will have a favorable impact on the supply of onions in the market. Gizaw (2013) and Melese et al. (2018) have verified that quintals serve as the unit of measurement for this

continuous variable. With increased output, households are more inclined to supply onion bulbs to the market. Therefore, the study anticipates that the total onion production of farm households will positively influence market supply.

2.5.2.2.2. Age of households (Age):

One contributing factor is the age of the household, which is a continuous variable measured in years. Given that age is a crucial element in assessing human capital, a positive correlation is anticipated. As individuals age, they tend to accumulate more experience in decision-making processes, such as allocating additional land, boosting production, or expanding market supply, as highlighted by Asale et al. (2016) and Mossie et al. (2020).

2.5.2.2.3. Family size (Fsize):

This is a continuous variable, determined by the total number of household members. A larger family size is expected to have a positive influence on onion production quantity and lead to lower production and marketing costs. Consequently, it is predicted to have a positive effect on the size of onion sales (Somano, 2008).

2.5.2.2.4. Education level (Edu):

The survey's continuous variable measures the respondent's level of formal education. Household heads with formal education are more likely to seek out new information on supply and demand, which can boost motivation among farmers to improve production and sales. A farmer's education level also affects how quickly they adopt new agricultural technologies, with more knowledgeable farmers likely to produce more and increase their market supply. As a result, we anticipate a positive correlation between the education level of the household head and the amount of goods supplied to the market.

2.5.2.2.5. Distance to nearest market (Dstmarkt):

The distance from the producer's home to the nearest market is a continuous variable measured in meters. The study suggests that as the market gets closer, transportation charges decrease, walking time is reduced, and other marketing costs decrease. Additionally, closer proximity to the market provides better access to market facilities. The hypothesis of the study is that the distance to the nearest market is inversely related to the supply of marketable surplus.

2.5.2.2.6. Farm Size (Fsize):

Land Allocated for Onion: This variable is anticipated to show a positive relationship with the dependent variable and is a continuous measure in hectares. Onion cultivation directly affects the supply volume as it is a cash crop. Expanding the land area for onion farming can lead to an increase in onion supply to the market. Kindie Aysheshim (2007) found that the land allocated for sesame production positively affected the marketable supply of sesame. Hence, it is hypothesized that the land area allocated for onion cultivation will positively impact the volume of onions supplied to the market.

2.5.2.2.7. Farming experiences (Exp):

The duration of a person's independent farming determines their level of farming experience. The farmer's experience is likely to impact the production and marketing of onions. It is theorized that the farmer's experience directly affects the supply of onions in the market, resulting in a substantial and positive increase in the quantity produced. Research conducted by Abay (2007), Ayelech (2011), and El. et al. (2013) has indicated that as farmers accumulate more experience, the quantity of tomatoes, avocados, and other crops supplied to the market also rises. Furthermore, studies by Adeoti et al. (2014), Oparinde and Daramola (2014), and Aragie E., Alemayehu M., and Abate A. (2023) have shown that the experience and farming practices of the household head significantly impact maize market participation.

2.5.2.2.8. Fngcdamnt and Insctcdamnt:

It is a continuous variable measured in kilograms or liters. Research conducted by Simon et al. (2015), Assefa et al. (2015), and Yohannes et al. (2013) revealed that the application of chemicals like insecticides, fungicides, and fertilizers during onion cultivation had a notable adverse effect on the amount of onions yielded and distributed to the market.

2.5.2.2.9-10. NPS and UREA fertilizers (NPS and UREA):

According to studies conducted by Simon et al. (2015), Assefa et al. (2015), and Yohannes et al. (2013), the application of fertilizers in onion seed cultivation was found to have a detrimental effect on the quantity of onions yielded and distributed in the market. The quantities were quantified in kilograms or quintals as continuous variables. Consequently, it is theorized that the land allocation decisions made by the head of the household negatively impact the production and distribution of onions in the market.

2.5.2.2.11. Distance to the market (Dstmrkt):

Asfaw et al. (2010) discovered that the proximity to the primary market is inversely correlated with the marketed surplus because of the increased transaction costs associated with marketing farmers' agricultural products. This factor is quantified in kilometers or hours and is also associated with enhanced access to seeds and other necessary agricultural inputs. The distance from the farmer's residence to the nearest market is quantified continuously in meters. A nearer market leads to decreased transportation costs, less time spent walking, and lower overall marketing expenses (Melese et al. 2018).

2.5.2.2.12. Oxen owned (Oxen):

This is a continuous variable measured in terms of tropical livestock units (TLU). The assumption was that households with a higher number of livestock have more economic strength and financial resources to buy sufficient inputs and use manure as a production input for onions. Research by MoFEC (Ministry of Finance and Economic Cooperation) (2019) and Hailu et al. (2015) has indicated that households with a greater livestock count typically produce and supply more potatoes. The hypothesis in this study was that TLU has a negative and significant impact on the quantity of onions supplied to the market.

2.5.2.2.13. Average price of onion (Avrgprcekg) lagged price:

The price of onion in the previous year (2014/15 E.C) is a continuous variable measured in birr per quintal/kg. There is a direct correlation between the past price of onion and the current supply of onion. High prices in the past incentivized farmers to increase their onion supply in the present. Research conducted by Haji & Alemu (2012) and Tola & Ketema (2014) indicated that previous market prices have a negative effect on the marketable supply of onion. Therefore, it is hypothesized that the lagged market price will negatively impact the volume of onion supply and production quantity.

2.5.2.2.14. Labor availability (Labor):

Farmers with access to labor are likely to be more open to innovation compared to those without, as increased onion production requires extra effort. The variable is based on the man equivalent of domestic labor and is considered a continuous variable. Research by Somano (2008), Tijani (2006), and Tchale and Sauer (2007) has demonstrated that the labor utilized has a statistically significant positive impact on the quantity of onions produced and sold in the market, with a significance level of 0.5%. Therefore, it was hypothesized that the labor of the household head would positively and significantly affect the quantity of onions produced and supplied to the market.

2.5.2.2.15. Sale of onion (Saleofonion):

Total income from onion sales is a continuous variable measured in birr. The existence of a market for agricultural products enables small-scale farmers to shift from subsistence to market-oriented farming (Abdullah et al., 2019). Linking farmers to the market and assisting in the sale of their produce is essential for boosting the income of disadvantaged farmers (Njuki et al., 2011). Therefore, it was predicted that the total income from onion sales by household heads would positively and significantly influence the quantity of onions produced and supplied to the market.

This low yield results indicate that the presence of a huge gap in production and productivity at the country because of the absence of improved cultivars, application of inappropriate agronomic practices and limited attention/awareness on the benefits of intensive production.

Within the context of efforts to achieve safe, sound and sustainable production of vegetables, identification of risk sources plays a crucial role (Kumilachew et al., 2014).

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Table 4 : Descriptions of variables including in the analysis of the study results

Variables	Description	Unit of Measurement	Expected sign
Dependent Variables			
Mrktspply	Quantity of onion sold in qt	Continuous variable	+ve
Independent variables			
Qtprd	Quantity of onion produced in qt	Continuous variable	+ve
Age	Age of household head in years	Continuous variable	-ve
Fsize	Numbers of households in the family	Continuous variable	+ve
Edu	Educational status of households head	Categorical Variable	-ve
Exp	House hold onion producing and marketing experience in years	Continuous variable	+ve
Dstmarkt	Distance from household residence to the nearest market (walking hours or km)	Continuous variable Continuous variable	+ve
Frmsize	Total land allocated for onion production in ha	Continuous variable	-ve
NPS	Amount of NPS applied in kg or qt	Continuous variable	-ve
NPS	Amount of UREA applied in kg or qt	Continuous variable	+ve
Fngcdamnt	Amount of fungicide sprayed in gm or liters	Continuous variable	-ve
Insctcdamnt	Amount of insecticide sprayed in liters	Continuous variable	+ve
Avrgprcekg	Price paid in birr per kg or qt	Continuous variable	-ve
Saleofonion	Total incomes from the sold of onion in Birr	continuous variables	+ve
Oxen	Total number of oxen owned by household	Continuous variable	-ve
Lobar	Labor force engagement for onion production and marketing	Continuous variable	+ve

Source: Review of previous literature and study area context, (2015).

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3. Results and Discussion

The key findings of the study are presented in this chapter. The analysis focused on descriptive statistics concerning the socio-demographic attributes of farm households, along with both quantitative and qualitative results. The econometric model results indicated a statistically significant relationship at the 0.5% level between the quantity of onions supplied to the market and different explanatory and dependent variables. Additionally, the chapter delves into the opportunities and obstacles encountered by producer farmers in onion production within the research area.

3.1. Descriptive study

The socio-demographic characteristics of the farm households, including sex, family size, age, education, farming experience, farm size allocated for onion production, labor, distance to the main market, average price of onion bulb, NPS used, UREA used, amount of fungicide and insecticide applied, income from sale of onion bulb, quantity of onion bulb consumed at home, and quantity produced and supplied, are crucial factors in onion bulb production and marketing. According to Table 4, the majority of the households were headed by males (approximately 97.37%), with a mean age of 34.89 years. The education levels of household heads varied across the sample kebeles, with 19.3% being illiterate, 74.56% attending primary school, 3.51% attending secondary school, and 2.63% attending higher education.

Table 5: Marital status, Educational level and Sex of the respondents

Marital status	**Freq.**	**Percent**	**Cum.**
Married	99	86.84	86.84
Single	15	13.16	100
Total	114	100	
Educational level	**Freq.**	**Percent**	**Cum.**
Degree	3	2.63	2.63
Illiterate	22	19.3	21.93
Primary education	85	74.56	96.49
Secondary education	4	3.51	100
Degree	3	2.63	2.63
Total	114	100	
Gender	**Freq.**	**Percent**	**Cum.**
Female	3	2.63	2.63
Male	111	97.37	100
Total	114	100	

Source: field survey result, 2015

The average family size of the total sample households was 5.1, ranging from 1 to 18, which can be considered a proxy for labor availability. The average farming experience of the sample respondents was 2.69 years, with a standard deviation of 3.44 years, ranging from zero to 20 years in onion production experiences as shown in Table 5 below. Land is a crucial factor in onion production, serving as the main source of income and enhancing the status of smallholders in the community. The average land allocated for onion bulb production by sample smallholder farmers was 0.27 hectares, and the average onion yield per household was 19.69 quintals. Of the average quantity produced per household, 18.64 quintals were sold at an average price of 16.73 Birr per kilogram.

The average annual total income of the households involved in selling onion bulbs was 332,824.60 Birr, with a range from zero to 2,436,000.00 Birr. The average NPS usage per hectare among the sampled households was 125kg, ranging from 100kg to 250kg, while the average UREA usage was 83.55kg, ranging from 50kg to 200kg. On average, each household owned 1.41 TLU (Oxen), with a range from 0 to 5.

The average number of laborers involved in onion production per household was 37.54, with a range from 16 to 112. The primary sources of irrigation for onion production in Gololcha Woreda were rivers, with nearly 93.86% of the sampled respondent households relying on them. Around 58.77% of the onion producers obtained loans from their accounts. Additionally, 59.65% of the onion producers in the study area had access to extension services. The most commonly used improved onion seed varieties among producer farmers in the area were Bombay Red, Adama Red, and Nafis, making up 52.63% of the total.

Table6: Descriptive summary of the study

Variable	Obs.	Mean	Std. Dev.	Min	Max
Fsize	114	5.10	3.28	1	18
Edu	114	5.36	4.11	1	15
Exp	113	2.69	3.44	0	20
Dstmarkt	114	34.78	33.67	4	180
Frmsize	114	0.27	0.16	0	1.5
NPS	114	125.00	40.60	100	250
UREA	114	83.55	31.35	50	200
Fngcdamnt	114	3.17	1.64	1	11
Insctcdamnt	114	2.66	1.33	0.75	8
Mrktspply	114	18.64	12.88	0	101.5
Qtprd	114	19.68	12.79	5	102
Saleofonion	114	332824.60	291097.80	0	2436000
Avrgprcekg	114	16.73	4.53	0	30
Oxen	114	1.41	1.02	0	5
Labor	114	37.54	15.61	16	112

Source: Own Survey data, (2015).

3.2. Factors affecting quantity of onion supplied to the market.

Multiple regression analysis is used when there are two or more independent variables that are believed to affect one or more dependent variables (Kothari, 2004). This analysis helps determine how much the independent variables explain the variation in the dependent variable, indicating the strength of the relationship. The adjusted R squared, R^2, is used to measure this relationship. A multiple linear regression model was used to examine fifteen independent variables. Of these variables, eight (experience in onion production, farm size, fungicide amount in gm/lit, insecticide amount in lit, quantity of onion produced in qt, average price, onion sales/income, and oxen) were found to significantly impact the quantity of onions supplied to the market in the district.

However, the remaining seven variables (age of the household head, family size, educational level, distance to the main market, amount of URE and NPS applied) did not demonstrate significant linear predictive values in the model. Therefore, the significance of the independent variables in the model is interpreted in relation to the dependent variable (quantity of onions supplied to the market), with the hypothesized signs and magnitudes of the model coefficient variations presented in Table 5.

3.2.1. Model Fitness

R-squared = 0.9793, indicating that the model explains 97.93% of the variance in market supply. A higher R-squared value suggests a better fit, capturing a significant portion of the variability in the dependent variable (Hair et al., 2010). The adjusted R-squared is 0.9761, which considers the number of predictors in the model and penalizes unnecessary variables. This high adjusted R-squared value reinforces the model's strong explanatory power (Field, 2009). The F-statistic and p-value (F (15, 97) = 306.00, Prob> F = 0.000) evaluate the overall significance of the model. The high F-value and low p-value indicate the model's statistical significance, suggesting that at least one predictor variable significantly influences market supply (Wooldridge, 2016). The Root Mean Squared Error (RMSE) is 1.993, representing the average difference between observed and predicted values. A lower RMSE indicates a better fit, but the interpretation should consider the data and dependent variable scale (Hyndman & Koehler, 2006). This information is summarized in table 7.

Table7: Econometric model test result of onion supplied to the market since 2023

Source	**SS**	**Df**	**MS**
Model	18,235.68	15	1215.71
Residual	385.37	97	3.97
Total	18,621.05	112	166.26

Mrktspply	**Coef.**	**Std.Dev.**	**T**	**P>t**	**95% Conf.**	**Interval**
Qtprd	0.359	0.059	6.060	0.000	0.242	0.477
Age	-0.034	0.031	-1.090	0.278	-0.096	0.028
Fsize	0.118	0.104	1.140	0.257	-0.088	0.325
Edu	-0.080	0.049	-1.640	0.105	-0.177	0.017
Exp	0.241	0.066	3.670	0.000	0.111	0.371
Dstmarkt	0.004	0.001	0.600	0.547	-0.008	0.002
Frmsize	-6.011	1.909	-3.150	0.002	-9.800	-2.223
NPS	-0.003	0.006	-0.590	0.559	-0.014	0.008
UREA	0.008	0.007	1.220	0.224	-0.005	0.027
Fngcdamnt	-0.378	0.171	-2.220	0.026	-0.717	-0.039
Insctcdamnt	0.470	0.207	2.270	0.026	0.058	0.881
Avrgprcekg	-0.287	0.070	-4.090	0.000	-0.427	-0.148
Saleofonion	0.000	2.990	10.780	0.000	0.000	0.000
Oxen	-0.501	0.200	-2.510	0.014	-0.898	-0.105
Labor	0.007	0.013	0.550	0.580	-0.019	0.033
_cons	7.605	1.749	4.350	0.000	4.134	11.076

Numbers of obs. = 113, F (15, 97) = 306.00, Prob > F = 0.000, R-squared = 0.9793, adjusted R-squared = 0.9761, Root MSE = 1.993

Source: Survey data model output result, (2015)

3.2.1. Farmer's onion production experiences

The study showed that the experience of the household head in onion farming had a positive impact on the amount of onions produced and sold in the market. The analysis also indicated that the experience of households in onion farming positively influenced the quantity of onions produced and sold.

This suggests that for each additional year of farming experience, there was a 0.5kg increase in the amount of onions produced and a 0.47kg increase in the quantity sold in the market. Therefore, households with greater experience in onion farming were able to produce and sell more onions compared to those with less experience, holding all other factors constant. This discovery is in line with earlier research conducted by Abay (2007), Ayelech (2011), and El et al. (2013), indicating that as farmers accumulate more experience, the quantity of tomato, avocado, and other crops they supply to the market also rises. Furthermore, the findings are consistent with the studies of Adeoti et al. (2014) and Oparinde and Daramola (2014), which showed that the experience and agricultural methods of household heads have a significant impact on their participation in the maize market.

Additionally, the research revealed that having experience in farming onions had a beneficial and noteworthy effect on the success of onion production. Specifically, a one-year rise in farming experience resulted in a 24.1% boost in the success rate of onion production, holding all other variables constant. This indicates that as farmers accumulate more experience in onion farming, they enhance their cultivation techniques and acquire superior managerial abilities, ultimately leading to enhanced onion production and management. This outcome aligns with the conclusions drawn by Aragie E., Alemayehu M., and Abate A. (2023).

3.2.2. Land Allocated for onion:

The findings show that the land designated for onion cultivation has a significant adverse effect on onion sales volume at a 0.5% significance level, as expected. Specifically, for each additional hectare of land allocated to onion production, the amount of onions supplied to local markets decreased by 6.01 quintals, holding all other factors constant. This decline in supply can be attributed to the high production costs and limited availability of inputs like fertilizers, pesticides, and quality onion seeds, which ultimately impacted the yield in the study area. Moreover, as the prices of these inputs increased in the market, farmers chose to reduce their usage, leading to lower yields and decreased onion supply to the markets. It is clear that by optimizing input utilization, farmers could have boosted their yields and supplied more onions to the markets.

Conversely, those who used fewer inputs experienced lower yields and provided less to the markets. This result is consistent with a study by Tozooneyi T. (2017), which revealed that an expansion in farm size was linked to a reduction in tomato commercialization, highlighting the influence of land allocation decisions on crop commercialization levels.

3.2.3. Quantity of pesticides sprayed

The results of the multiple linear regression models indicated that the amount of fungicide applications had a negative impact on the quantity supplied to the market, while the amount of insecticide applications had a positive impact, all other variables being equal. Specifically, a one gram or liter increase in fungicide application led to a 0.378 qt decrease in the quantity supplied, whereas a one-liter increase in insecticide application resulted in a 0.47 qt increase in the quantity supplied to the market.

These findings suggest that increasing fungicide spray during application intervals reduced fertilizer application and related technology in onion production. This increase in fungicide spray also raised production costs and decreased the quantity of onions produced by small-scale landholding farmers, impacting the amount of fungicide sprayed at all intervals due to uncontrolled fungicide use in the study area. On the other hand, higher quantities of insecticides sprayed during onion production led to an increase in the quantity supplied to the market. Both results indicate that uncontrolled fungal outbreaks, resulting from inadequate fungicide application, led to decreased yields and reduced quantities supplied to the market. Many farmers in the study area suffered losses in marketable bulb production due to fungal diseases. The soil in rural areas often faced fungal diseases as farmers did not rotate onion crops with other plants. Insect attacks were more effectively managed by spraying insecticides, enabling farmers to achieve higher yields for market supply.

These results are in line with the studies conducted by Bekele and Abebo Bekele M, Chewaka M, Ollika B (2019), Feleke, et al. (2019), Khalil, et al. (2014), Yirga, et al. (2015), Diriba, et al. (2015), Nazziwa-Nviiri, et al. (2019), Diriba, et al. (2019), and Ketema, et al. (2015), which all demonstrated that various technological factors positively affected the adoption of potato technology. Furthermore, the findings are consistent with the research of Ahmed et al. (2003) and Bezabih and Hadera (2007), indicating that factors such as family size, disease outbreaks, pests, drought, water pumping fuel prices, fertilizer use, and pesticide sprays had a significant impact on muskmelon productivity.

3.2.4. Quantity of Onion Produced:

As predicted, the results of the multiple linear regression analysis confirm that the quantity of onion produced has a significant positive impact on the amount of onions supplied to the market at a significance level of 0.5%. This indicates that for every quintal increase in onion production, there is a corresponding 0.36 quintal increase in the supply of onions.

This suggests that households that produce more onions are likely to supply more to the market, as they have less need for personal consumption. This finding is consistent with the study conducted by Fayera, B. and Benyam, T. (2019), which also found a positive and significant relationship between potato production and marketable supply.

3.2.5. Average price in kg/ Lagged price

The study found that the variations in the positive and negative coefficients of average prices and lagged prices suggest a seasonal trend in the relationship between lagged prices and onion production. The influence of the previous year's price on current production is more pronounced compared to earlier delayed prices. The study suggests that an increase in last year's price will lead to higher current onion production, driven by the seasonal cyclical impact of lagged pricing on onion production. Therefore, assuming no changes in onion demand, onion prices are expected to remain low. These results align with the findings of Haji & Alemu (2012) and Tola & Ketema (2014).

3.2.6. Onion sales/income from the sale of onion

The results show a clear and statistically significant correlation between the revenue earned from selling onions and the amount of onions produced and sold in the market, while keeping all other variables constant. The data also shows that, on average, 0.27 hectares of land were used for onion cultivation, and the average income from onion sales in the 2022 production year was 332,824.60 Birr.

3.2.7. Oxen used for onion production

The study discovered that there was a notable 5% negative correlation between the number of oxen utilized for cultivating onion farms in the region and the quantity of onions supplied to the market, while keeping all other variables constant.

This implies that for every additional unit increase in the number of oxen, the quantity supplied to the market decreased by 0.501qt. This finding aligns with previous research conducted by Pender and Alemu (2007) and Gebremedhin and Jaleta (2010a), which also indicated that livestock ownership negatively affects crop market participation due to the alternative cash income they offer.

3.2.8. Labor availability:

The study revealed that having more laborers in farm households has a positive and significant effect on onion production. An additional laborer is associated with a 0.007 qt increase in onions sold in the market, holding all other variables constant. This suggests that households with a greater number of laborers are more inclined to engage in onion production for commercial purposes in the study region. This result aligns with previous studies in developing nations, underscoring the role of family labor in improving onion production efficiency and overall agricultural yield (Aragie E., Alemayehu M., and Abate A., 2023).

3.4. Major Constraints and Opportunities in Onion Production and Marketing

The respondents identified marketing and production problems as the main issues in the study area related to onion production and marketing.

3.4.1. Opportunities

The producer farmers in the study area had access to improved onion and local varieties, connections with agriculture offices and research centers, irrigation water resources, farmer training centers, opportunities for local traders and wholesalers, infrastructure development (including rural electrification, roads, markets, and cooperatives), labor availability, and experienced onion producer farmers. Access to improved onion seed in the study area were one of the best sources of for onion production and marketing presented in Table 8 below. This study aligns with the findings of Beshir (2012) and Kanna (2016), Fitsum Miruts, Bedru Beshir, and Gadisa Ejersa (2021), and Nega et al. (2015).

Table 8: Onion seed varieties used in 2014/15 production year

variety produced 2013/14	Freq.	Percent	Cum.
Adama red	7	6.14	6.14
Bombay red	48	42.11	48.25
Local	54	47.37	95.61
Nafis	5	4.39	100
Total	114	100	

Source: Field Survey data, (2015)

3.4.2. Constraints of onion production and marketing:

Marketing onions in Gololcha Woreda encountered several challenges. Respondents highlighted issues such as a lack of knowledge in onion production, price manipulation by brokers, insufficient market information, and difficulties in establishing market links, resulting in pricing uncertainties in anticipation of onion bulb sales. Additionally, productivity and marketability were hampered by various pests and diseases.

Production problems: The study area encountered major difficulties in acquiring high-quality onion seeds, as most sources were informal and only had small plots available. Other challenges included disease and pest issues such as root rots, water scarcity, low production levels, limited access to extension services, and disorganized input distribution. Farmers obtained seeds from the open market without certification, quality testing, or assurances. Additionally, inadequate agronomic practices like insufficient tillage, chemical fertilizer application, watering, and weeding also impeded onion production in the region.

Marketing challenges: The onion crop in Gololcha Woreda faced difficulties due to a lack of accurate market information.

This resulted in inefficiencies in negotiations, with well-informed individuals having an advantage over others. The simultaneous harvesting by most producers led to an oversupply compared to demand, causing lower prices due to the bulkiness, perishability, and seasonality of the product. Weight discrepancies were common, and traders wielded significant power in the market. The absence of organized unions/cooperatives for onion marketing meant that farmers had little influence over prices. Furthermore, the limited market research in the area hindered authorities from making informed decisions about marketing channels and the overall system. (Mume T., 2007; Teka SG. 2009).

4. Conclusion

The study examined data from 114 households in the Gololcha Arsi Zone, Oromia Regional State, focusing on onion production. The majority of participants were male-headed households with formal education, cultivating an average of 0.27 hectares of land for onions. The average income from onion bulb sales was 332824.60 Birr in the 2022 production year. Multiple linear regression models were utilized to analyze the marketing supply of smallholder onion producers, revealing that eight explanatory variables had a significant correlation with onion sale volume in the market. Factors such as onion quantities produced, farmers' experiences, insecticide amount, and total income were positively associated with onion supply, while farm size, fungicide amount, oxen use, and average onion price had a negative correlation. Improved onion seeds were provided by formal institutions, with Bombay Red, Adama Red, and Nafis being the most popular varieties. Approximately 52.63% of the onion supply in the area originated from formal institutions. Furrow irrigation from rivers was the primary water source, utilized by 93.86% of households. Around 59.65% of households had access to agricultural extension services, while 40.35% did not receive advice on onion production.

Most households had access to loans (58.77%), but 41.23% did not receive credit for onion production. Challenges in onion seed production included informal seed sources, disease and pest issues, poor production practices, limited access to extension services, and uncoordinated input distribution. Producer farmers in the area had opportunities for improved onion varieties, connections with agriculture offices and research centers, irrigation water resources, farmer training centers, local trading opportunities, infrastructure development, labor availability, and experienced onion producers.

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